

## REMARKS

Applicant submits this Amendment "E" and Response for the Examiner's consideration. Reexamination and reconsideration of the application, as amended, in view of the following remarks are respectfully requested.

### **1. STATUS OF THE CLAIMS**

Claims 1-28 and 36-63 were presented for examination and they stand rejected and pending in the application. The pending claims stand rejected under 35 U.S.C. §§ 112 ¶ 1, 103(a). These rejections are addressed below.

### **2. RESPONSE TO REJECTIONS**

#### **2.1. Claim Rejections Under 35 U.S.C. § 112 ¶ 1**

The pending claims are rejected in the Office Action under 35 U.S.C. § 112 ¶ 1 "as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention." Office Action, p. 2.

The foregoing quotation from the Office Action indicates that this rejection is asserted for an alleged failure to comply with the written description requirement.<sup>1</sup> Applicant sets forth below

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<sup>1</sup> The Office Action also asserts that there is in the rejected claims "[s]ubject matter not enabled by the specification as originally filed". Office action, p. 2. As quoted above, the reasons for the rejection as given in the Office Action are stated in terms of paragraphs 7.30.01 and 7.31.01 as set forth in M.P.E.P. § 706.03(c). These reasons do not include paragraph 7.31.02 that should be provided in a rejection for an alleged failure to comply with the enablement requirement. *See, e.g.*, M.P.E.P. § 706.03(c), pp. 700-47, -48 (Aug. 2001). *See also, e.g.*, M.P.E.P. §§ 2161, 2164, pp. 2100-153, -173 (Aug. 2001) (indicating that the three requirements in 35 U.S.C. § 112 ¶ 1 are three separate and distinct requirements). Therefore, Applicant addresses the present rejections in light of the written description requirement, and respectfully submits that there is no issue concerning the

the standard for determining whether a claim satisfies the written description requirement, and then shows, by providing numerous instances of support in the application as filed, that the claim recitation that is challenged in the Office Action and the subject matter claimed in the rejected claims satisfy the written description requirement.

“To satisfy the written description requirement, a patent specification must describe the claimed invention in sufficient detail that one skilled in the art can reasonably conclude that the inventor had possession of the claimed invention.” M.P.E.P. § 2163.I, p. 2100-155 (Aug. 2001). “The fundamental factual inquiry is whether the specification conveys with reasonable clarity to those skilled in the art that, as of the filing date sought, applicant was in possession of the invention as now claimed.” M.P.E.P. § 2163.I.B, p. 2100-158 (Aug. 2001). *See also* M.P.E.P. § 2163.02, p. 2100-167 (Aug. 2001). “[A] satisfactory description may be in the claims or any other portion of the originally filed specification” and “[a]n applicant shows possession of the claimed invention by describing the claimed invention with all of its limitations using such descriptive means as words, structures, figures, diagrams, and formulas that fully set forth the claimed invention.” M.P.E.P. §

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enablement requirement because no rejection on the basis of the enablement requirement has actually been asserted in the Office Action. If any rejection were asserted with respect to the enablement requirement, Applicant would respectfully request that such rejection be fully and properly asserted so that it could be addressed by the Applicant.

The Office Action also asserts that a limitation that was introduced by claim amendment “constitutes new matter”. Office action, p. 2. Under governing legal principles and established patent application examination procedure, “[i]f the Examiner concludes that the claimed subject matter is not supported [described] in an application as filed, this would result in a rejection of the claim on the ground of a lack of written description under 35 U.S.C. 112, first paragraph, .... The claim should not be rejected or objected to on the ground of new matter.” (bracketing in the original) M.P.E.P. § 2163.01, p. 2100-167 (Aug. 2001). Therefore, Applicant addresses the present rejections in light of the written description requirement, and respectfully submits that there is no issue concerning new matter because no objection on such basis has actually been asserted in the Office Action. If any objection were asserted with respect to alleged new matter, Applicant would respectfully request that such objection be fully and properly asserted so that it could be addressed by the Applicant.

2163.I, p. 2100-155 (Aug. 2001) (citing *Lockwood v. American Airlines, Inc.*, 107 F.3d 1565 (Fed. Cir. 1997)). Furthermore, the “subject matter of the claim need not be described literally (i.e., using the same terms or *in haec verba*) in order for the disclosure to satisfy the description requirement.” M.P.E.P. § 2163.02, p. 2100-167 (Aug. 2001). *See also*, M.P.E.P. § 2163.I.B, p. 2100-157 (Aug. 2001).

The Office Action asserts that “forming a conductive layer on the seed layer including the portion of the seed layer within the recess” is not disclosed because “the specification does not disclose [(1)] forming the conductive layer on the seed layer including portions of the seed layer within the recess; [(2)] forming the energy absorbing layer on the conductive layer; and [(3)] applying, omnidirectionally, energy to the energy absorbing layer to cause the conductive layer to flow within the recess” (Office Action, p. 2; numbers added for later reference), and the Office Action concludes by stating that “the specification as originally filed does not indicate that the conductive layer is formed within the recess prior to being flowed into the recesses.” (Office Action, p. 3).

The claim language that incorporates an amendment introduced in Amendment “D” and Response recites: “forming an electrically conductive layer on the seed layer including the portion of the seed layer within the recess.”<sup>2</sup> *See, e.g.*, claim 1, and variations of the same language in claims 16, 23, 24, 28, 36, 45, 48, 57, and 62. This recitation is fully supported in the written description and also, and independently, in the drawings as filed. The cites and references to the written description and drawings provided below are meant to be illustrative of the support to the claim language, and such cites and references are not provided as interpretive limitations.

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<sup>2</sup> With some variations, this is the language referred to in item (1) above.

Figure 2 shows a conductor layer 28 formed on a seed layer 26. As is also shown in Fig. 2, seed layer 26 extends within recessed structures formed into dielectric material 14, such as trench 32, hole 34 and the hole/trench structure 18/20 shown within contour 12. Fig. 2 also shows that conductor layer 28 is formed on portions of seed layer 26 and also on portions of seed layer 26 that are within any one of the recessed structures such as the trenches and holes shown therein. Therefore, Fig. 2 shows an electrically conductive layer on a seed layer, including the portion of the seed layer that is within the recessed structure, or recess for short. Because the claim language that was introduced by amendment is fully shown in at least one of the drawings as filed, Applicant has satisfied the written description requirement.

Formation of a conductor layer on a seed layer is also described in the application at, for example, p. 4, *ll. 22-26*, p. 5, *ll. 1-14*; brief description of Fig. 2 at p. 7 (indicating that each interconnect structure has “one or more layers of each of a barrier layer, a seed layer, a conductive layer, and an energy absorbing layer.”); p. 9, *ll. 19-26*, and p. 10, *ll. 1-25* (describing formation of a conductor layer on a seed layer). In addition to the support provided by the features shown in Fig. 2, the application describes the formation of a conductor layer on a seed layer, including the portion of the seed layer that is within the recessed structure or recess. Because the claim language that was introduced by amendment is fully described in the written description, Applicant has satisfied the written description requirement.

The Application as filed also provides support for item (2) referred to above. Figure 2 shows energy absorbing layer formed on conductor layer 28. Because the claim language referred to as item (2) is fully shown in at least one of the drawings as filed, Applicant has satisfied the written description requirement. In addition to the support provided by the features shown in Fig. 2, the application describes the formation of an energy absorbing layer on a conductive layer. Forming an

energy absorbing layer on a conductive layer is described in the Application at, for example, p. 5, *ll. 7-26*, and p. 6, *ll. 1-4*; p. 10, *ll. 18-25*, and p. 11, *ll. 1-10*. Because the language in item (2) is fully described in the written description, Applicant has satisfied the written description requirement.

The Application as filed also provides support for item (3) referred to above. The application describes omnidirectional application of energy to the energy absorbing layer to cause the conductive layer to flow within the recess at, for example, p. 5, *ll. 23-26*, and p. 6, *ll. 1-7*; p. 12, *ll. 7-14*. Furthermore, some of the examples of ways to apply energy to an energy absorbing layer that are given in the written description, illustrate devices that provide such energy in substantially all directions within the source, and thus describe forms of omnidirectional application of energy. Because the language in item (3) is fully described in the written description, Applicant has satisfied the written description requirement.

The Office Action formulates the following question: "If the conductive layer is already formed in the recess, how can it be caused to flow within the recess upon carrying out the step of omnidirectionally heating the energy absorbing layer?" Office Action, p. 2. The explanation is also fully contained in the Application as filed, such as in the illustrative passages from the Application that are cited above. These passages are now revisited again to address this question.

A conductor layer such as conductor layer 28, is formed according to the recited method. Formation of such layer on an underlying layer, such as seed layer 26 and within a recessed structure, however, does not guarantee a void-free filling of the space within the recessed structure, such as a trench or hole above seed layer 26. This is due to any one or to a combination of various factors, such as limitations inherent to the conductor layer formation technique, and challenging aspect ratios of the structure that is filled. These voids lead to defects and poor step coverage, problems that are set forth in the Application as filed at, for example, p. 2, *ll. 11-26* and p. 3, *ll. 1-4*. In contrast, the

question set forth in the Office Action seems to imply that the filling of a recessed structure necessarily leads to a void-free filling and to an optimal step coverage. This is, however, contrary to the problems experienced in the art as set forth in the Application. As also stated in the Application as filed, p. 3, *ll. 5-6*, it is desirable to overcome the problems of poor step coverage and voids, and these problems are overcome by the claimed methods as indicated in the Application as filed at, for example, p. 13, *ll. 3-6*. To overcome these problems, the claimed methods include the formation of a conductor layer, such as conductor layer 28, and the subsequent formation thereover of an energy absorbing layer, such as energy absorbing layer 30. The claimed methods further include the application of energy to such energy absorbing layer so that the applied energy causes an already formed electrically conductive layer that may have voids and/or poor step coverage to flow within the recess in which it is already formed, and thus eliminate voids and/or improve step coverage. As shown herein, these operations in the manufacturing of an interconnect structure are consistent with the description provided in the Application as filed, in the recited claim language, and in remarks set forth in Amendment "D" and Response, such as those at p. 31, item (5) therein.

As set forth above, Applicant has shown support in the original disclosure for the amended claims. To the extent that the same rejection is to be reasserted, Applicant respectfully requests that evidence or reasoning for such rejection be provided. Having shown support in the Application as filed, Applicant notes that "[t]he examiner has the initial burden of presenting evidence or reasoning to explain why persons skilled in the art would not recognize in the original disclosure a description of the invention defined by the claims." M.P.E.P. § 2163.II.A.3.b, p. 2100-165 (Aug. 2001) (quotation to *In re Wertheim*, 541 F.2d 257, 263 (C.C.P.A. 1976) omitted).

In light of the support shown herein, Applicant submits that the pending claims comply with 35 U.S.C. § 112 ¶ 1, and reconsideration and withdrawal of these rejections are respectfully requested.

**2.2. Claim Rejections Under 35 U.S.C. § 103(a)**

Rejections under 35 U.S.C. § 103(a) are asserted in the Office Action in view of Xu, *et al.*, U.S. Pat. No. 5,668,055 (hereinafter “Xu”) or in view of Xu in combination with Schacham-Diamond, *et al.*, U.S. Pat. No. 5,824,599 (hereinafter “Schacham”) “as previously applied in the Office Action mailed 3/8/01”. Office Action, p. 3.

The Office Action states that arguments set forth in Amendment “D” and Response concerning rejections under 35 U.S.C. § 103(a) “are moot in view of the new ground(s) of rejection as necessitated by the instant amendment.” As shown above, the new grounds for rejection under 35 U.S.C. § 112 ¶ 1 that have been asserted in the Office Action in light of the amended claim language introduced in Amendment “D” and Response have been traversed and full support in the Application as filed has also been shown. Applicant restates and incorporates herein the arguments set forth in Amendment “D” and Response because the amended claim language is fully supported in the Application as filed and thus arguments made on the basis of such language may not be considered moot on such grounds.

Applicant addresses hereinbelow the remarks set forth in the section entitled Response to Arguments in the Office Action.

**2.2.1. Response to Arguments, item 6, Office Action, pp. 3-4.**

The Office Action indicates that “Xu does teach the formation of a layer of conductive material [] over the seed layer, not only on the flat and horizontal portions of the seed layer, but also

on the seed layer within the recesses (see Figure 4 of Xu, and related text, for example).” Office Action, p. 4.

Xu shows in Fig. 4 compressibly stressed metal layer 30 that has been extruded into a recess after formation of cap layer 40 thereover, wherein the metal layer is in contact with barrier layer 20 that could be eliminated, depending on the substrate. Xu, Fig. 4, col. 3, ll. 55-60. The reference teachings from Xu that are cited in the Office Action do not teach the structural elements, such as a seed layer, and the operations of formation of such elements that are recited in the present claims. Because of this absence of teachings in Xu, Applicant reasserts the arguments set forth in this regard in Amendment “D” and Response.

#### 2.2.2. Response to Arguments, item 7, Office Action, p. 4.

The Office Action indicates that the closing of item (2) in Amendment “D” and Response, p. 30, is not clear and invites Applicant to clarify this issue. Office Action, p. 4. Applicant clarifies this issue as follows:

Xu discloses the formation of cap layer 40 in tensile stress to restrain upward displacement of patternable metal layer 30 upon extrusion. This physical condition of tensile stress in cap layer 40 is required in Xu. *See, e.g.*, Xu, Fig. 5, third block from the top, col. 2, ll. 30-31, 34-38, col. 6, ll. 21-36, 45-48, col. 7, ll. 40-48, col. 8, ll. 33-34. In contrast, an energy absorbing layer is formed on the electrically conductive layer in the presently claimed methods according operations that include: “forming an electrically conductive layer on the seed layer including the portion of the seed layer within the recess” and “forming an energy absorbing layer on said electrically conductive layer”. (*See, e.g.*, claim 1 and variations of such language in the other independent claims). Xu does not form an energy absorbing layer on an electrically conductive layer that has been formed within the recess. Xu forms cap layer 40 on patternable metal layer 30 prior to the extrusion of patternable

metal layer into openings 14 and 16 therein. Furthermore, Xu does not form an electrically conductive layer on a seed layer within any recessed structure because Xu does not show the formation of any seed layer at all. In addition, Xu teaches the formation of cap layer 40 on patternable metal layer 30 so that, with the aid of such cap layer 40, metal layer 30 can subsequently be extruded into openings 14 and 16. *See, e.g.*, Xu, col. 6, ll. 20-67, col. 7, ll. 1-56. In contrast, the claimed methods recite the formation of an electrically conductive layer on the seed layer including the portion of the seed layer within the recess prior to the formation of an energy absorbing layer. Therefore, the operation whereby patternable metal layer 30 is formed into openings 14 and 16 in Xu is different from and cannot lead to the formation steps recited in the present claims. For at least the reasons set forth above, Xu teaches the formation of cap layer 40 for a different function than that recited in the present claims for the absorbing layer. Furthermore, the formation characteristics of the various layers in openings 14 and 16 in Xu are different from the formation characteristics of the various layers in the recessed structures as recited in the present claims.

#### 2.2.3. Response to Arguments, item 8, Office Action, p. 4.

The claims in the present application are method claims for manufacturing interconnect structures. These claims recite limitations concerning operations and concerning formation of structures with such operations. The standards for obviousness thus apply to prior art teachings regarding all the limitations —and not just a selected few— that are recited in the claims, with each claim viewed in its entirety or as a whole. Even if Xu, *arguendo*, disclosed identity of materials,<sup>3</sup>

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<sup>3</sup> As shown herein, however, Xu does not teach identity of materials and/or structures. For example, Xu discloses that the material in barrier layer 20 is an electrically conductive material such as titanium nitride, whereas claims 3 and 4 recite materials comprised in the barrier layer as selected from ceramics, metallics, and intermetallics, and from aluminum nitride, tungsten nitride, titanium nitride and tantalum nitride, respectively. Claims 7 and 8 recite materials comprised in the seed layer, whereas Xu does not disclose any such layer. Claim 9 recites material comprised in the conductor layer that is formed within the recess structure and on the seed layer as selected from the

distilling the claimed methods to focus only on material comparisons would completely disregard the principle that it is the invention as a whole, and not some part of it, which must be obvious under 35 U.S.C. § 103(a), and that a prior art reference must be considered in its entirety, including the portions that would lead away from the claimed invention. *See, e.g.*, M.P.E.P. § 2141.02, pp. 2100-118 to -120 (Aug. 2001).

2.2.4. Response to Arguments, item 9, Office Action, p. 4.

The Office Action acknowledges that “Xu does not disclose or suggest the formation of a barrier layer and a seed layer, the characteristics, features, and advantages of forming a seed layer and a barrier layer as instantly claimed and supported by the specification”, but the Office Action further states in connection with these differences that they “may follow from the teachings in Xu” and that “the provision for a barrier layer and seed layer as instantly claimed and supported by the specification” is “within the knowledge of persons of ordinary skill in the art”. Office Action p. 5.

Applicant respectfully submits that a bare statement that claimed subject matter is within the ordinary skill in the art, particularly when there is no dispute as to the failure of the reference teachings to disclose or suggest the formation of a barrier layer and a seed layer, the characteristics, features, and advantages of forming a seed layer and a barrier layer as claimed and supported by the

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group of Al and Cu, whereas Xu discloses that patternable metal layer 30 is made of a compressibly stressed metal such as aluminum bearing material, gold, silver, platinum and allows thereof, and that this layer is formed as a cover and not as a filler of openings 14 and 16 therein prior to the formation of cap layer 40 (Xu, col. 4, ll. 10-36); and claim 10 recites materials comprised in the energy absorbing layer as selected from the group of titanium, titanium nitride, tungsten, tungsten nitride, silicon nitride, silicon dioxide, tantalum, tantalum nitride and carbon, whereas Xu discloses carbon, silicon dioxide, titanium, tungsten and tantalum as materials for cap layer 40 (Xu, col. 6, ll. 54-57). Furthermore, as pointed out in the Office Action, the present claims recite relations amongst the material properties that Xu does not teach, disclose or suggest. In light of at least the foregoing differences, Applicant respectfully submits that the statement that “the materials taught by Xu are the same as those which are claimed” (Office Action, p. 4) does not apply and has no basis on the teachings of the cited reference.

specification, does not establish a *prima facie case* of obviousness in light of the reference teachings. First, the statement that the claimed subject matter is within the ordinary skill in the art, even though it has been acknowledged that it is not taught or suggested by the reference teachings, has been traversed by Applicant. Under these circumstances, it has been established that “[i]f the applicant traverses such an assertion the examiner should cite a reference in support of his or her position”. M.P.E.P. § 2144.03, p. 2100-129 (Aug. 2001) (setting forth examination standards when there is reliance on alleged knowledge in the art or “well known” prior art). Furthermore, and even if it were determined, *arguendo*, that some of the recited limitations were within the ordinary skill in the art, Applicant notes that it is also well established that the fact that the claimed invention is within the capabilities of one of ordinary skill in the art is not sufficient by itself to establish *prima facie* obviousness. *See* M.P.E.P. § 2143.01, p. 2100-124 (Aug. 2001).

#### 2.2.5. Response to Arguments, item 10, Office Action, p. 4.

Applicant in Amendment “D” and Response, item (8), p. 33, stated and reasoned, *inter alia*, as follows:

- (a) Applicant respectfully submits that the assertion that Xu discloses a ratio of 4:1 is not supported in Xu, and that, if anything, Xu discloses ratios significantly smaller than 4:1;
- (b) Because the previous Office Action cited the entire written description in Xu as support for the contention that Xu discloses an aspect ratio of 4:1, Applicant studied Xu and extracted in good faith relevant information that permits the calculation of an aspect ratio on the basis of the geometric parameters provided in Xu, and explicitly showed in Amendment “D” and Response the conclusion stated in (a) above. Applicant furthermore presented to the Examiner in Amendment “D” and Response the calculations that lead to such conclusion; and

(c) As shown by Applicant in Amendment "D" and Response, Xu does not appear to disclose an aspect ratio as recited.

In light of these considerations, Applicant reasserts the request made in Amendment "D" and Response to the effect that a cite to Xu pointing out with specificity where Xu produces such disclosure be provided, so that Applicant can address it further if this is deemed necessary.

Applicant incorporates herein the reasoning, arguments and legal and procedural authority set forth in Amendment "D" and Response in light of Xu and Schacham being applied in the Office Action "as previously applied in the Office Action mailed 3/8/01." Office Action, p. 3.

Consequently, Applicant respectfully submits that Xu, whether combined or not with Schacham, does not support a *prima facie* case of obviousness regarding the present claims. Applicant respectfully requests the reconsideration and withdrawal of this rejection.

3. **CONCLUSIONS**

In view of the above, Applicant respectfully maintains that the present application is in condition for allowance. Reconsideration of the rejections is requested. Allowance of the pending claims at an early date is solicited.

In the event that the Examiner finds any remaining impediment to a prompt allowance of this application which could be clarified by a telephonic interview, or which is susceptible to being overcome by means of an Examiner's Amendment, the Examiner is respectfully requested to initiate the same with the undersigned attorney.

Dated this 22<sup>nd</sup> day of January 2002.

Respectfully submitted,



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**Marked up Version of the Pending Claims Under 37 C.F.R. § 1.121(c)(1)(ii):**

No claim amendments have been introduced in this paper.